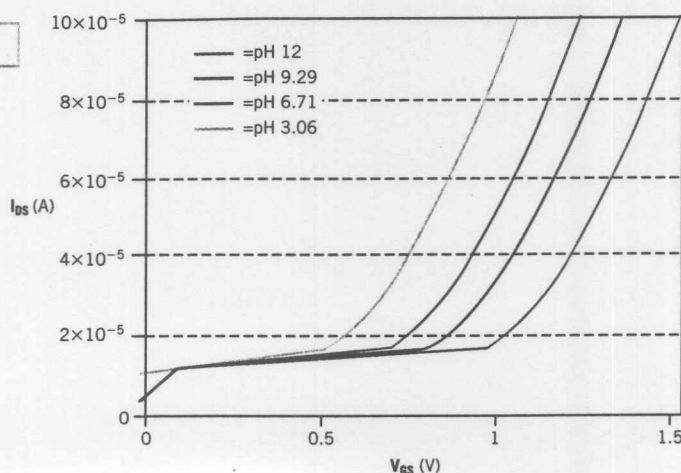


100- μ A current source and the internal current mirror. The second voltage follower measures the gate-source voltage of the sensor—hence, the chemical concentration of interest. **Figure 2** shows experimental results. You can see that the setup provides a linear relationship between gate-source voltage and the concentration of $[H^+]$ ions. The experiment used SiO_2 - and Si_3N_4 -based ISFET sensors. **Figure 3** shows the variation of the threshold voltage as a function of pH.

Figure 3



The gate-source voltage of an ISFET shifts with the degree of acidity.

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USB link neatly measures temperature

Mary Burke, Analog Devices, Limerick, Ireland

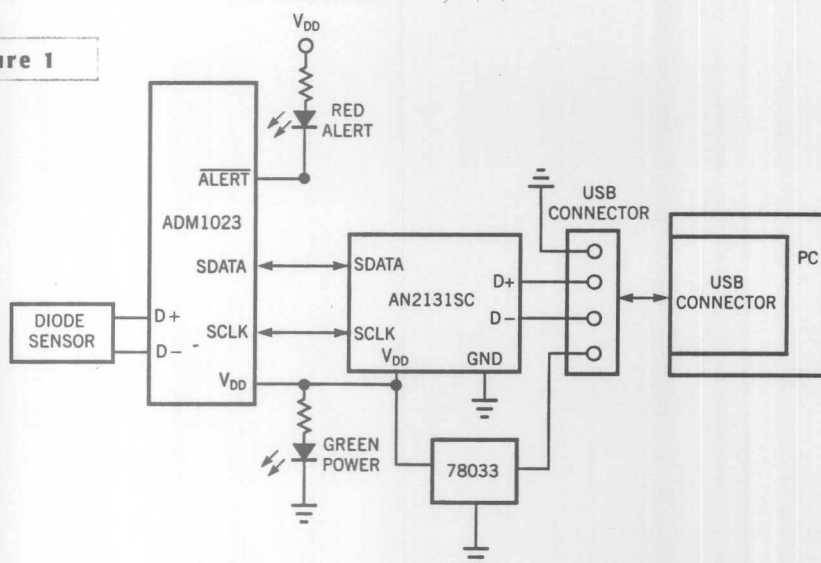
FIGURE 1 SHOWS A convenient and neat way to measure temperature using the USB of a PC. An ADM1023 IC senses the temperature, and an Anchor Chips EZ-USB AN2131SC μ C provides control. The ADM1023 is a low-cost device with an accuracy of 1°C and a resolution of 0.125°C . The IC is a two-channel device that can measure its own local temperature and the temperature of a remote location. You obtain remote-temperature sensing by connecting a remote thermal diode between the D+ and D- pins of the μ C. You can locate this remote diode (for example, a diode-connected 2N3906) in a hot spot that can be as far as 100 ft from the ADM1023. However, for distances greater than 12 in., you should use twisted-pair cable. For distances greater than 12 ft, you should use shielded twisted-pair cable, such as microphone cable.

The EZ-USB μ C includes an integrated I²C controller. This feature is useful in that the μ C communicates via I²C, thereby simplifying both the circuit and the μ C's firmware. The μ C takes care of the

lower level I²C signals. The firmware needs only to place the data destined for the I²C data register and to tell the μ C to send it. A second advantage of this μ C is the availability of on-chip RAM. You can

write Windows drivers such that the firmware automatically downloads to the RAM when you plug in the board. The μ C then simulates a disconnect and reconnects the board as a new device. This

Figure 1



Use the USB port on your PC to make quick and easy temperature measurements.

feature of the μ C is called renumeration. The circuit in **Figure 2** works as follows: The SDA and SCLK pins of the ADM1023 connect to the corresponding pins of the μ C. You need a 2.2-k Ω pullup resistor on both lines, because these pins have open-drain outputs. Also connected to these lines is a 24LC00, a 16-byte EEPROM. This ROM stores the board's device descriptors (the vendor and product IDs). Windows uses this information to identify which device driver to use.

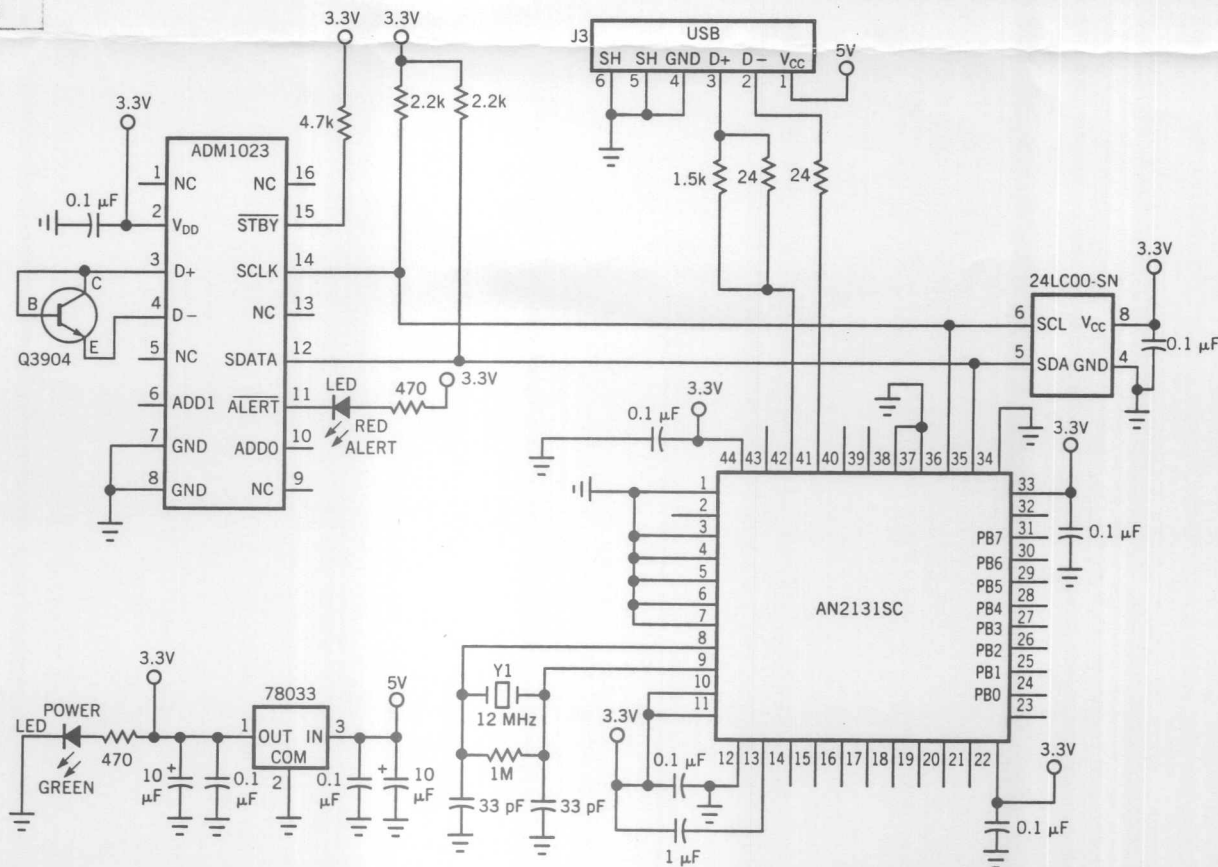
The remote thermal diode (or diode-connected transistor) connects between the D+ and D- lines of the ADM1023. The ADM1023 can also signal an Alert. You can program the IC with high and low temperature limits for both the local and the remote channels. If any of the

measured values of temperature are beyond the temperature limits, then the ADM1023 signals an Alert. The ALERT is active-low; an LED tied to the pin lights whenever an Alert signal arises. The USB port supplies power to the circuit. The port can supply as much as 500 mA at 5V. Because both chips in **Figure 2** operate at 3.3V, the circuit uses a 78033 regulator to generate the required 3.3V. The USB Master, which in this case is the application running on the PC, maintains control of the circuit. The master initiates all USB communications. The temperature-measurement circuit is the slave. It responds only when the master requests it to do so. When the master requests data (via the PC application), the request travels down the USB cable to the μ C. This

request consists of the device address of the ADM1023 and the address of the register that stores the data. It also tells the μ C whether a read or a write is required. The μ C then uses this information to interrogate the ADM1023 over the I²C interface. You can download the software used in this project from EDN's Web site. Click on "Search Databases" and then enter the Software Center to download the file for Design Idea #2596.

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Figure 2



This temperature-measurement system requires minimal components.